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# NOAA Science Advisory Board

## NOAA Research in the Chukchi and Beaufort Seas

Richard Merrick  
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NOAA Fisheries

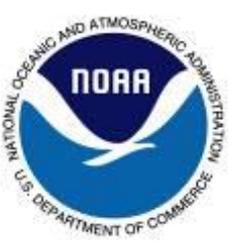


# Outline

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- Purpose
- Legislative and Climate Drivers
- Climate and Weather Research
- Ecosystem Research
- Desired Outcome



# Purpose

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- Provide overview of NOAA's involvement in Arctic science in response to 2012 request from ESMWG
- Request continuing involvement from the ESMWG in the development of NOAA's Arctic research program





# Legislative Drivers for US Arctic Science

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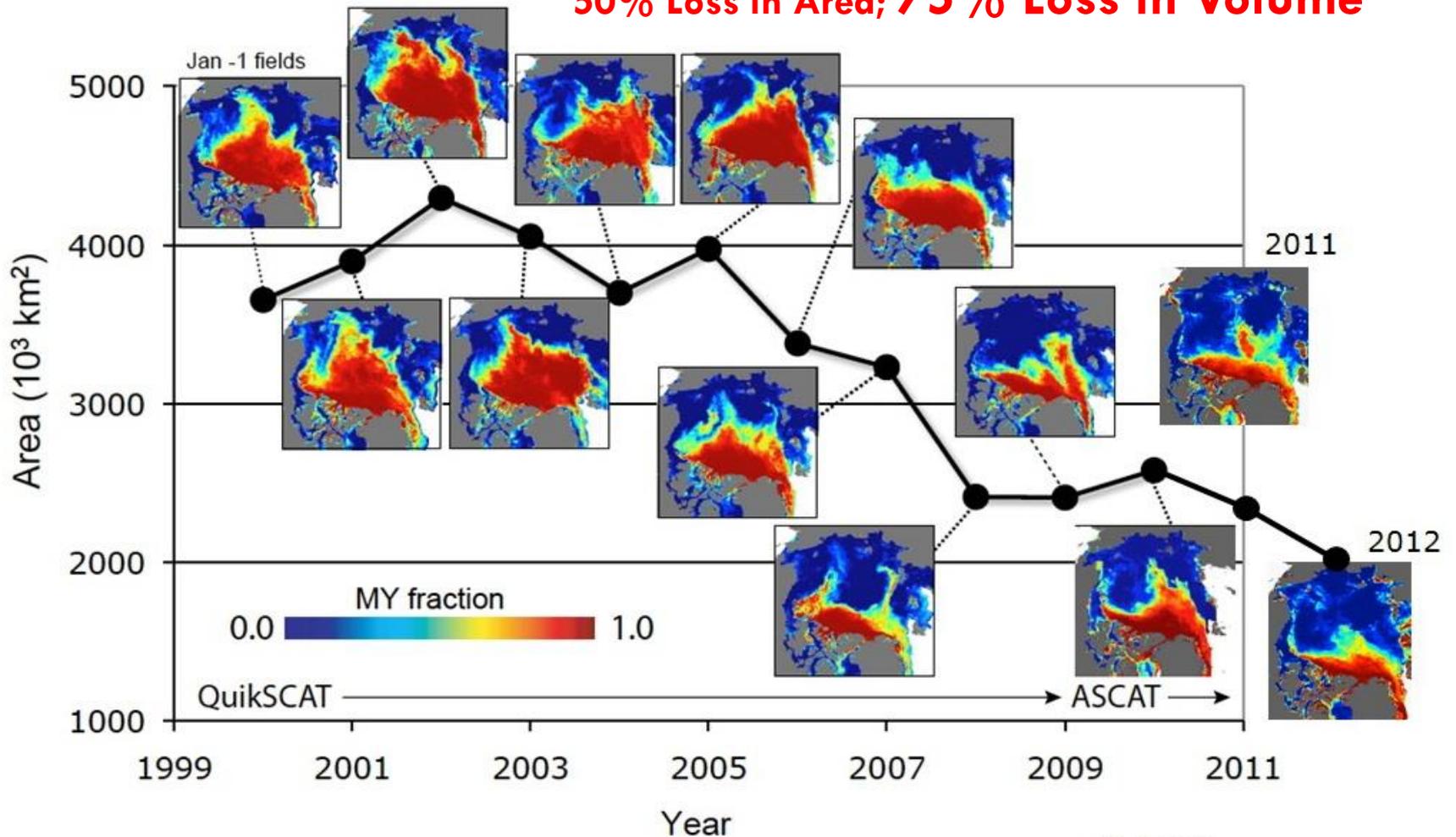
- Arctic Research Commission and Interagency Arctic Research Policy Committee (1984)
- National Ocean Policy (2010)
- NOAA's Arctic Vision and Strategy (2011)
- Interagency Working Group on Domestic Energy Development and Permitting in Alaska (2012)
- IARPC 5 Year Research Plan (2012)
- Integrated Arctic Management report (2013)
- US National Strategy for the Arctic Region (2013)



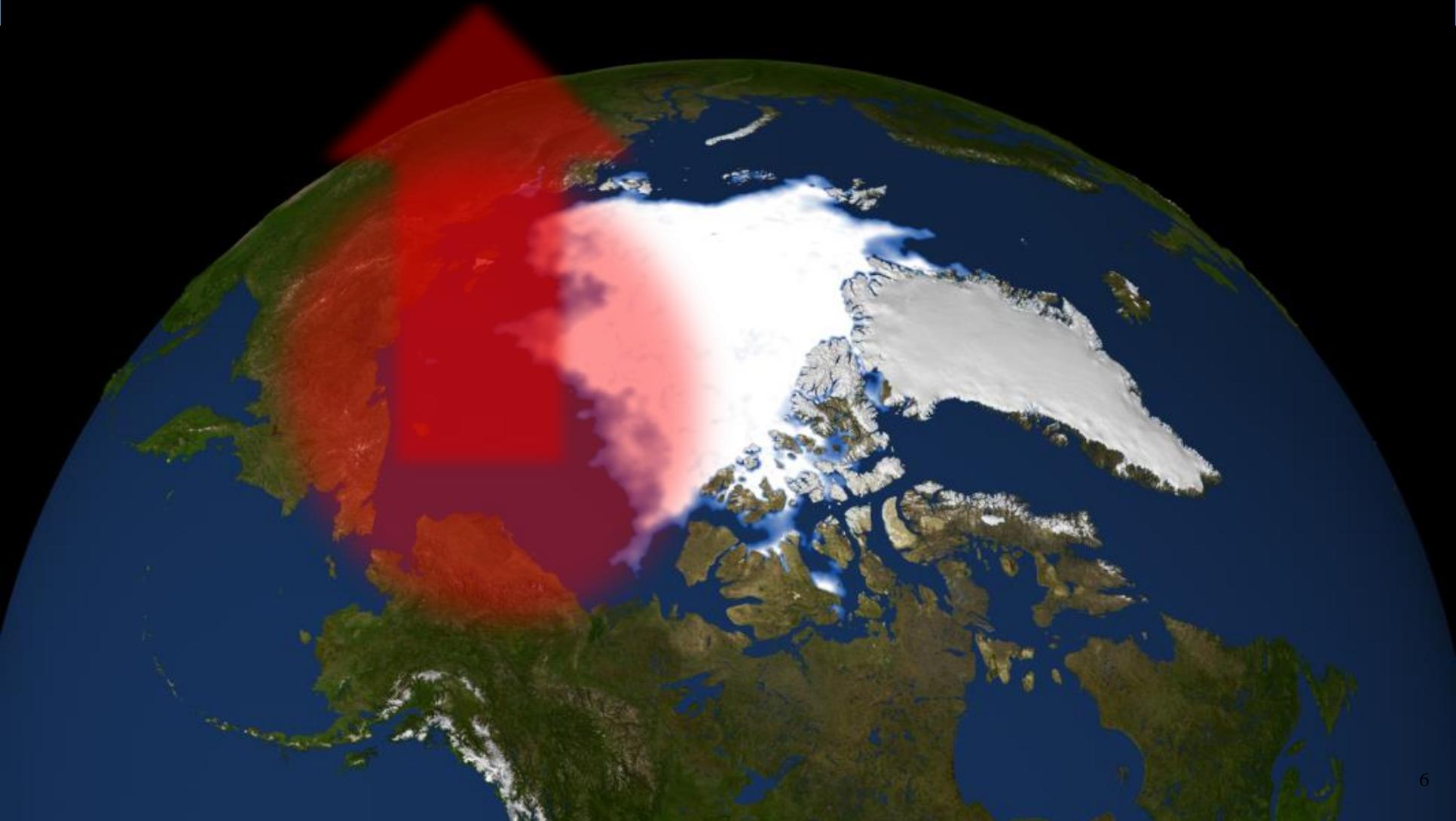
# Climate Driver

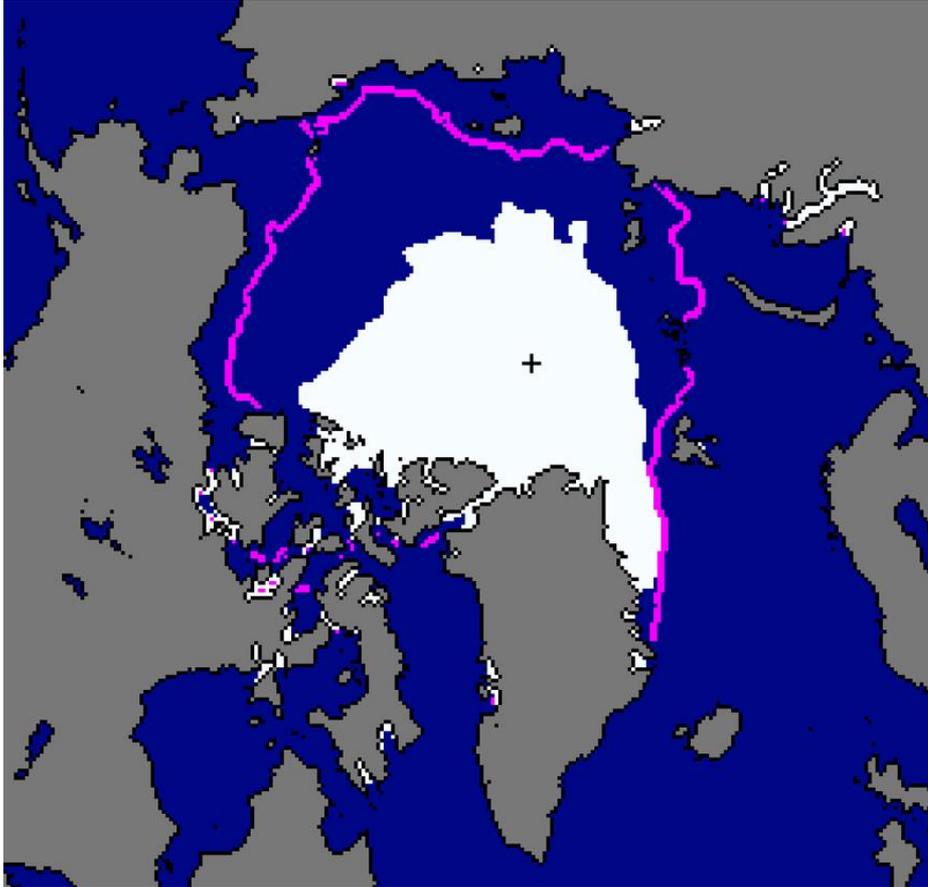
## Decline in Arctic Ocean Multiyear Sea Ice Coverage

**50% Loss in Area; 75% Loss in Volume**



# Added Ocean Heat Storage and Heat Flux from New Sea Ice Free Areas = More Storms





# Climate and Weather Research



# Arctic Research Program Climate Observations Division



## GOALS: 2002-2012

- To capture the transition of the Arctic from an ice covered ocean to an ocean where ice may disappear in the summer by 2030.
- Facilitate and deploy Arctic regional observational equipment (focused on the Pacific Arctic),
  - Arctic Atmospheric Observatories
  - Ice-Ocean-Ecosystem changes
  - Sea Ice Thinning: Causes and Consequences
- Carry out analysis of key variables in the atmosphere, ice, ocean and marine ecosystem parts of the Arctic climate system
- Document variability, detect change and evaluate impacts on marine ecosystems.

## GOALS: 2013-2014

- Focus on data and information analysis and synthesis RUSALCA
- Elucidate a new decade of Arctic Observations beginning in 2014



### Strategic Partners:

OAR OER, ESRL, PMEL, GLERL, AOML, GFDL

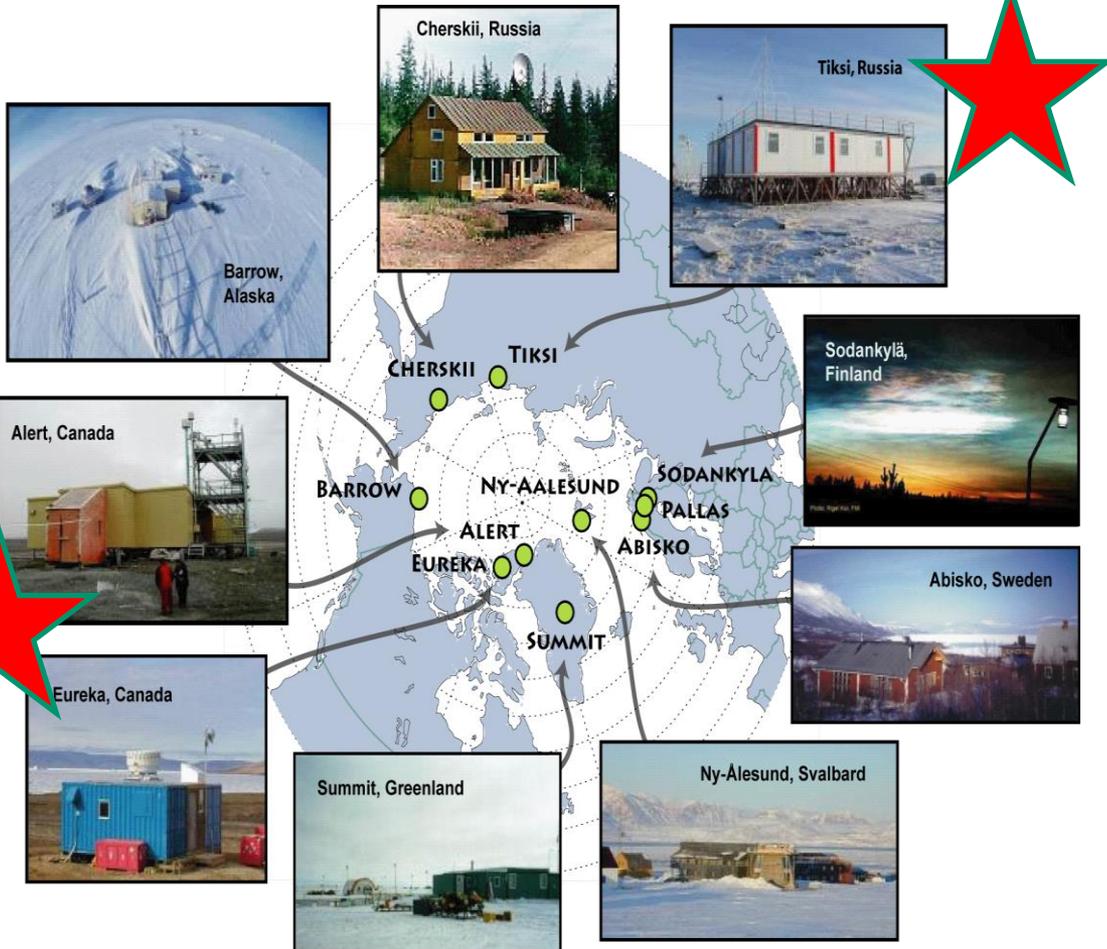
NOAA Lines NMFS-AFSC, NESDIS-NIC, NOS-AOOS

Interagency NSF, ONR, FWS, BOEM, NASA, USGS

US Academia UAF, WHOI, UW, UMD, OSU, CI



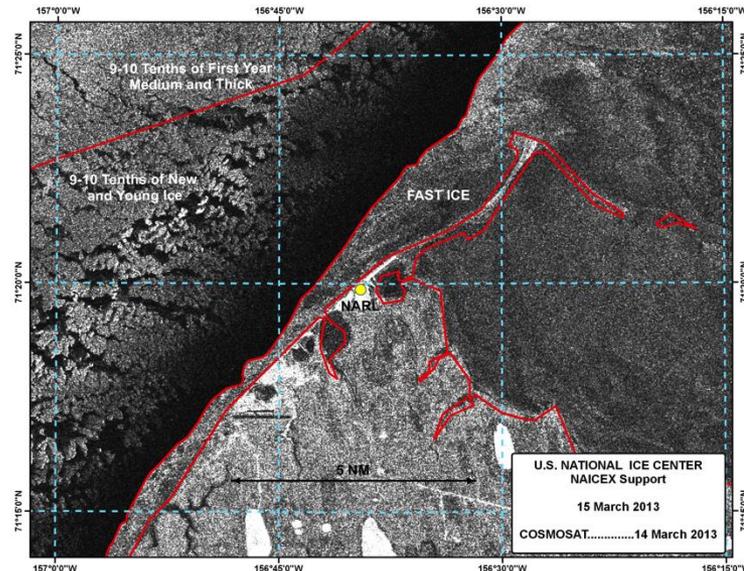
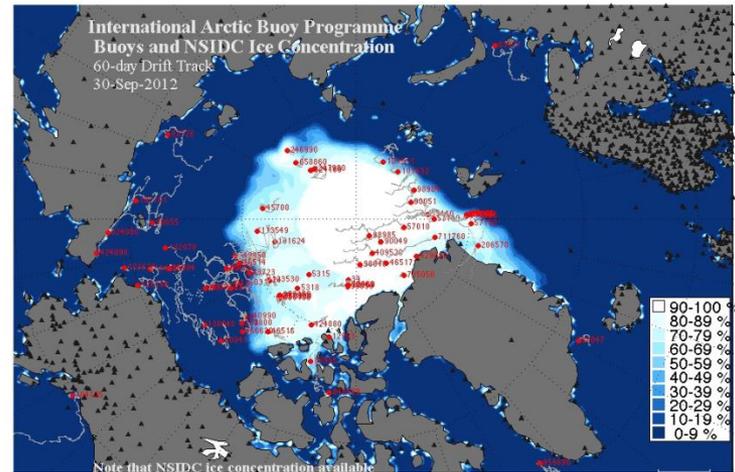
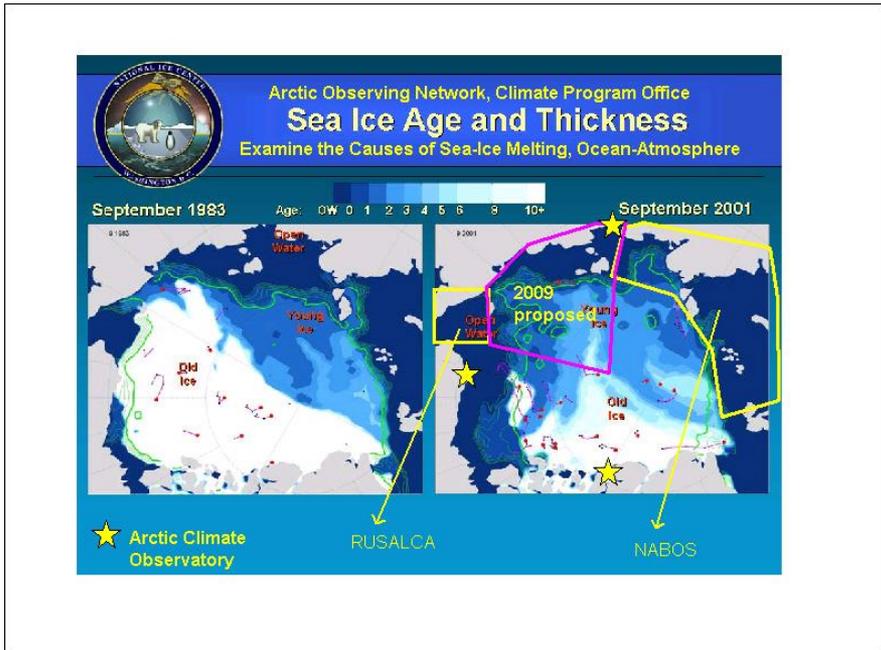
# Arctic Climate Observatories



- How do clouds, aerosols and atmospheric chemistry interact to force the Pan-Arctic surface energy balances and albedo-temperature feedbacks?
- What are the relative roles of tropospheric dynamics and stratospheric linkages in controlling the Arctic surface variability?
- What portion of the recent changes in the Arctic weather and climate can be attributed to increases in anthropogenic sources?
- How does the Arctic atmosphere interact with the rest of the Arctic (marine, cryospheric and terrestrial) system?



# Sea Ice Thinning Observations and Modeling



Sea Ice thinning enhanced by ocean heat transport, albedo feedback; and consequent new air-sea interactions.



# Experimental Seasonal Sea Ice Prediction

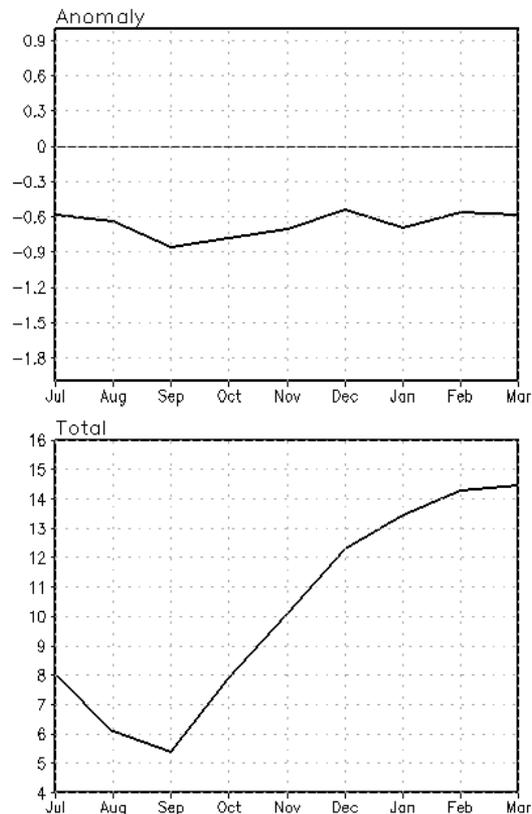


NWS/NCEP/CPC

Initial conditions: 21Jun2013–30Jun2013

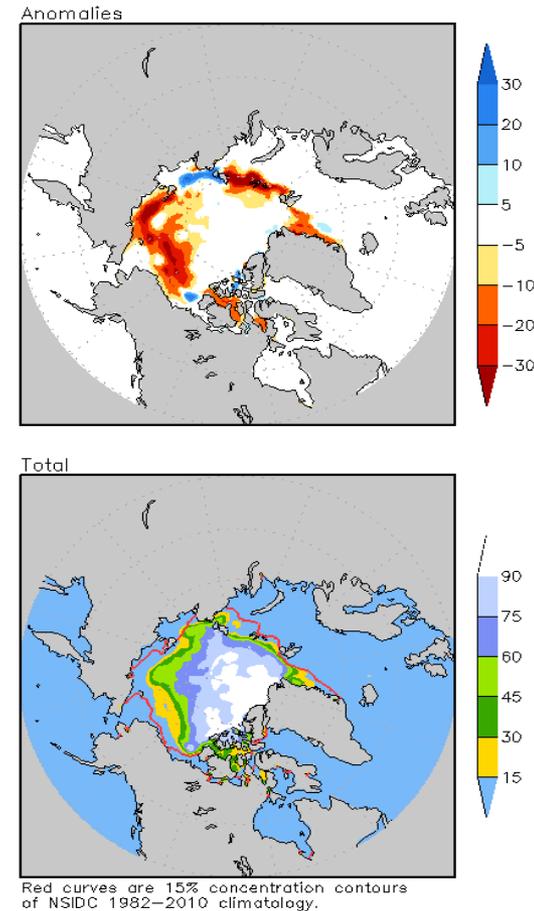
Last update: Tue Jul 2 2013

Sea ice extent ( $10^6 \text{ km}^2$ ) from CFSv2



Sea ice extent

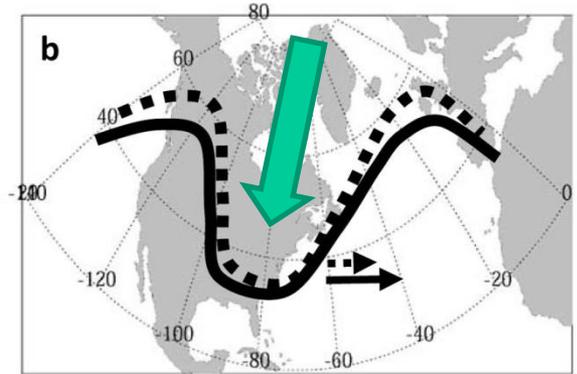
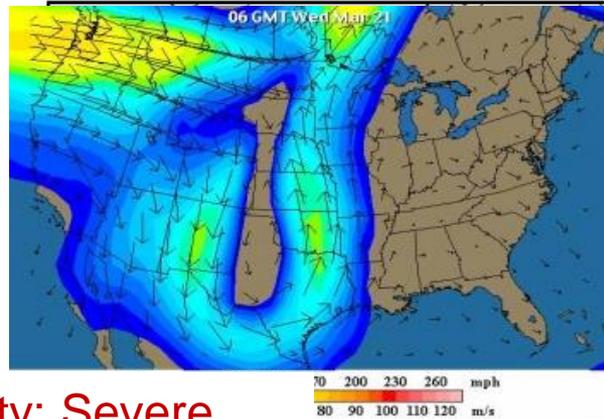
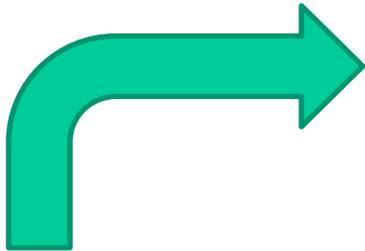
Sep 2013 sea ice concentration from CFSv2



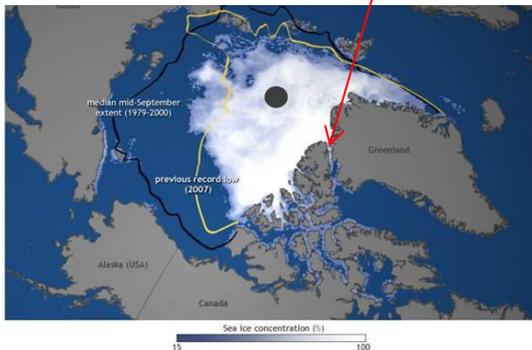
Sea ice concentration



# Arctic Climate Change Detection



## Arctic-Mid-latitude Connectivity: Severe Weather Consequences Generated by the Loss of Sea Ice

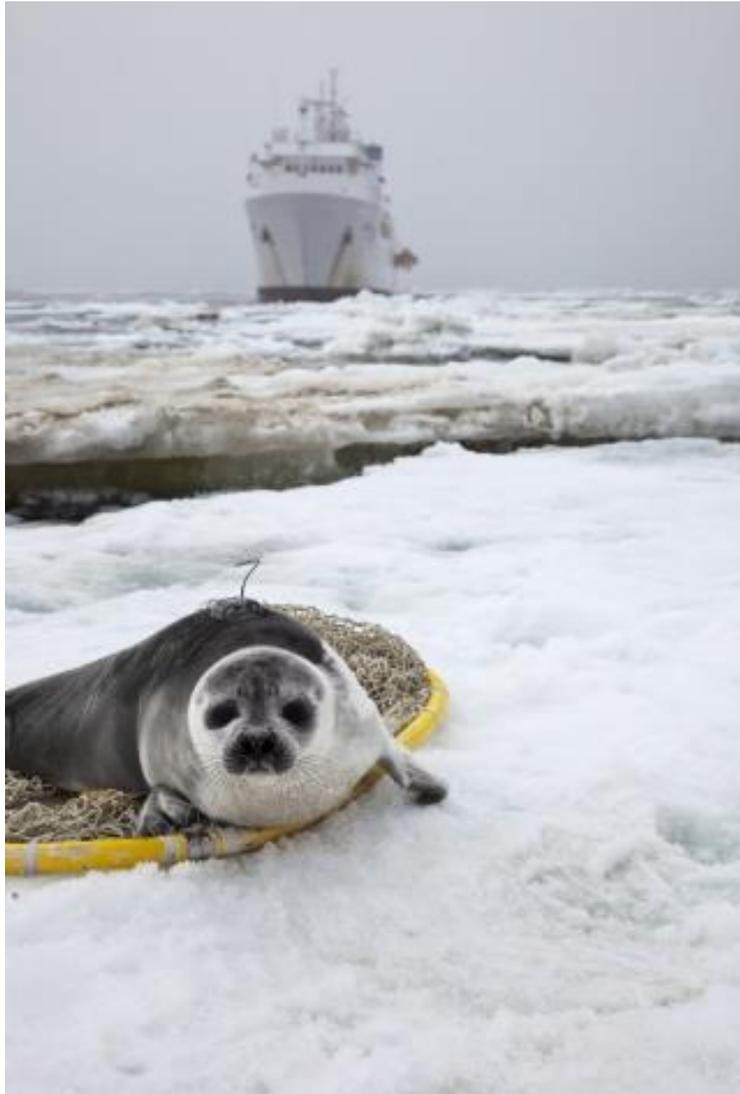


September 16. At 1.5 million square miles (3.41 million sq. km), it was a new record low: **18% smaller** than the previous record low, and **49% below** the long term average (1979-2000).

The last six years have the six smallest minimum extents since satellite observations began in 1979. As the ice pack shrinks, the ocean absorbs more sunlight, and warming accelerates, causing more ice loss. Wind patterns, clouds, ocean currents, and ecosystems are being transformed.

Sea ice extent on September 16, 2012.

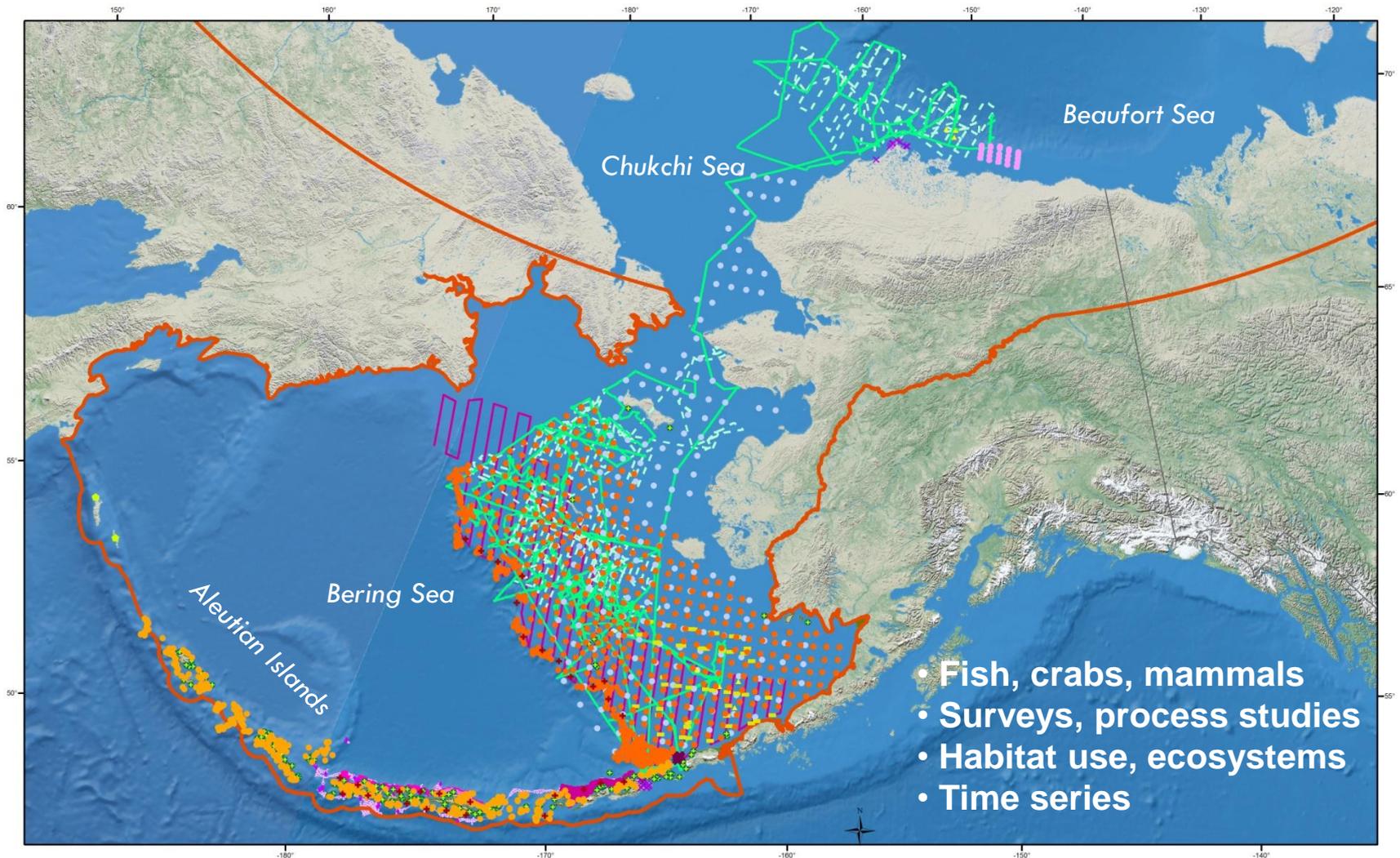
- **Jet Stream** slow-down from 55 km/hr. to 40 km/hr. Higher amplitude wobbles lead to severe weather



# Ecosystem Research



# Ecosystem Research Throughout ARPA Marine Areas





# Current Arctic Ecosystem Research

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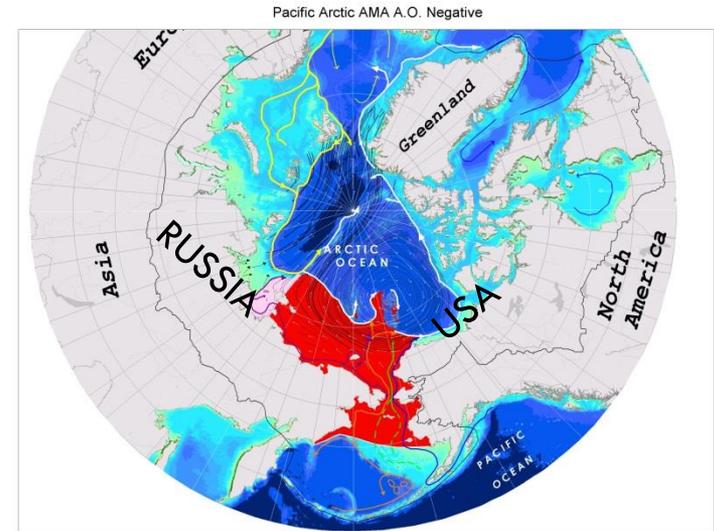
- Synthesis of Arctic Research (SOAR)
- Pacific Marine Arctic Regional Synthesis (PacMARS)
- Pacific-Arctic Gateway Ecosystem Study (PAGES)
- Arctic Ecosystem Integrated Survey (Arctic EIS)
- Aerial Survey of Marine Mammals
- ShoreZone
- Arctic Coastal Ecosystem Survey (ACES)
- Loss of Sea Ice-Ice Seal Surveys (LOSI)
- Chukchi Sea Environmental Studies Program (CSESP)
- Hanna Shoal Ecosystem Survey
- Marine Arctic Ecosystem Surveys (MARES)
- Bering Aleutian Salmon International Survey (BASIS)
- Russian-American Long Term Census of the Arctic (RUSALCA)
- Distributed Biological Observatory (DBO)
- U.S. Canada Transboundary Fish Survey



# Russian American Long-term Census of the Arctic



1. Take observations Where Arctic sea ice reduction is a maximum in the Pacific Arctic
2. Monitor fresh water, heat, nutrient fluxes and transport pathways through the Pacific Gateway to the Arctic
3. Monitor ecosystem indicators of climate change in the Pacific Arctic
4. Model and forecast changes in ecosystems and Arctic wide physical systems that impact global climate and ecosystem stability
5. Improve Russian-U.S. Arctic science relations
6. Explore the unknown Arctic



In A.O. Negative periods, the Pacific Arctic AMA is bound by the Lena River Outflow, the Atlantic Water Boundary Current, the Barrow Canyon and the Maximum Average Ice Extent in the Bering Sea

## The Pacific Arctic Region

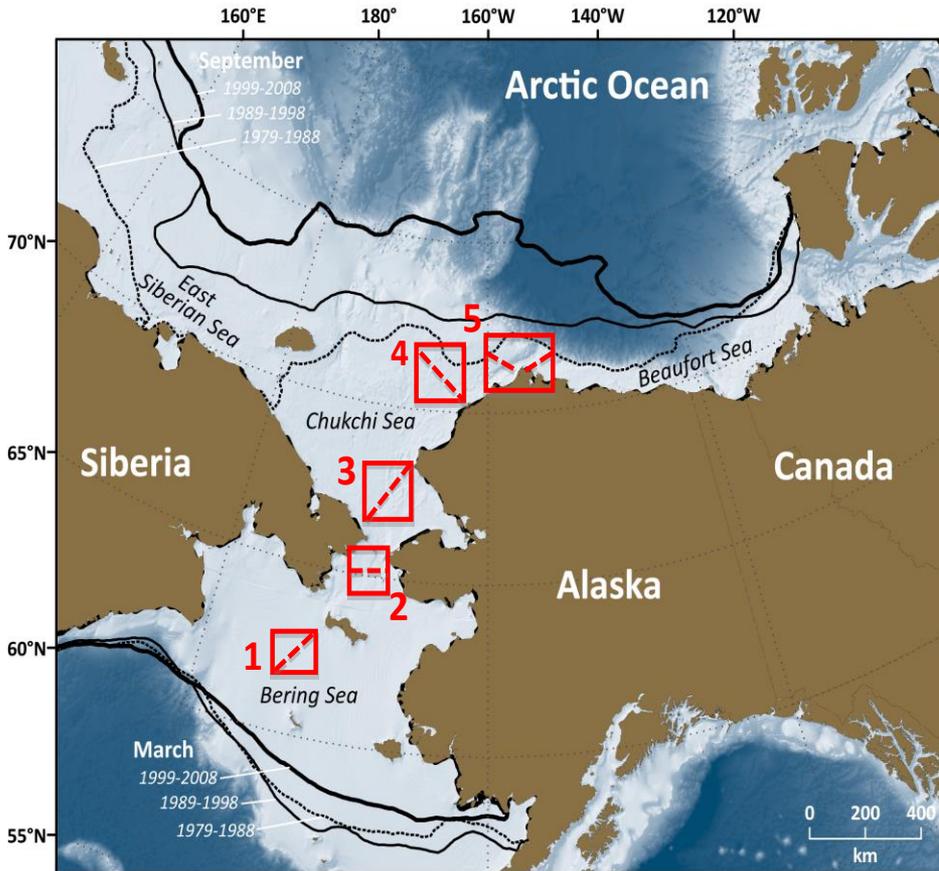


Co-funding with OER, NSF, RAS, Roshydromet, FWS



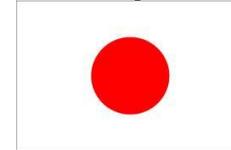


# Distributed Biological Observatory (DBO)



[modified by Karen Frey from Grebmeier et al. 2010, EOS 91]

- DBO regions are centered on biological “hotspots” along a latitudinal gradient
- DBO regions exhibit high productivity, biodiversity, and rates of change
- The DBO can serve as a *change detection array* via consistent sampling of biophysical processes
- Pilot Study (2010-12) focused in Regions 3 & 5; DBO data workshop just completed

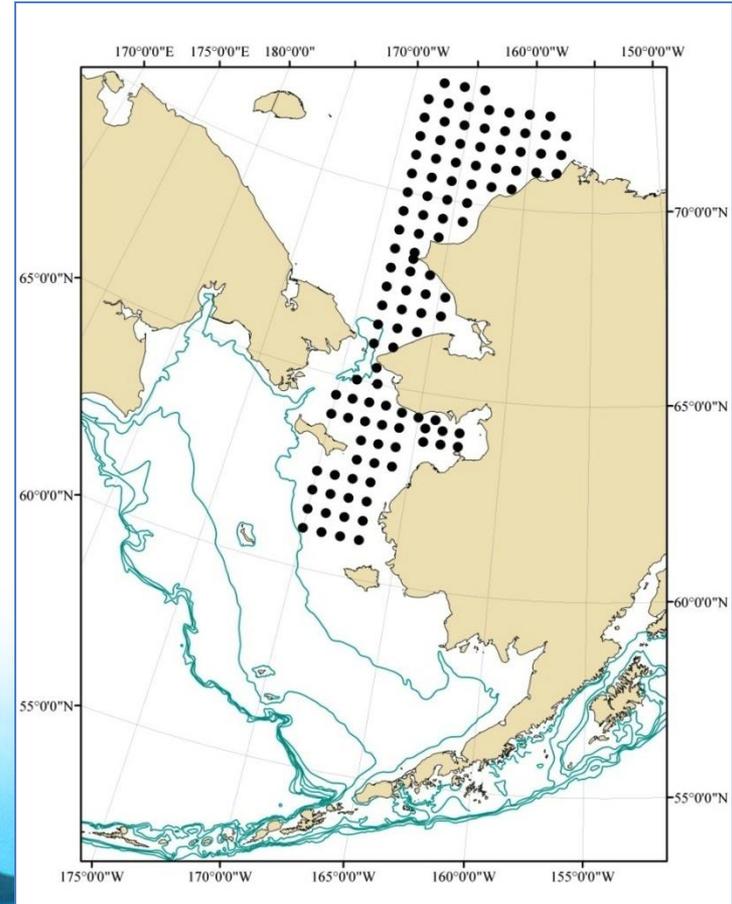




# Arctic Ecosystem Integrated Survey (Arctic EIS)



- ✧ Ocean circulation, physics & chemistry
- ✧ Plankton, salmon, Arctic cod, saffron cod, snow crab, capelin, seabirds
- ✧ Age, growth, diet, energetics, stock structure, ecosystem modeling

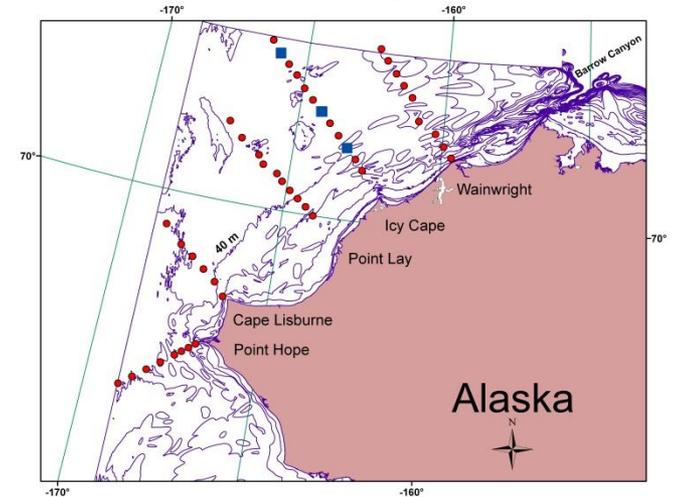




# Chukchi Acoustics, Oceanography, and Zooplankton: 2010-2015



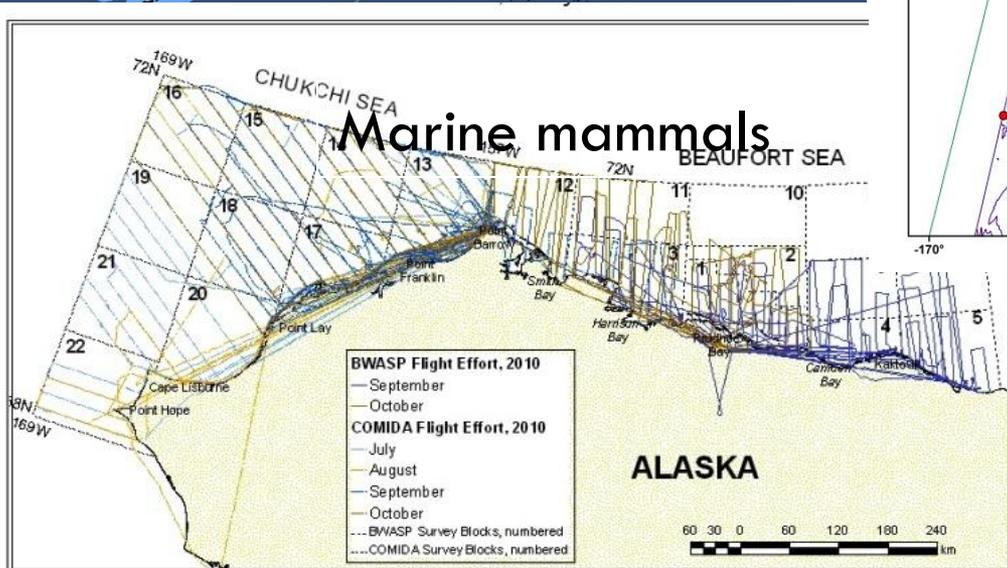
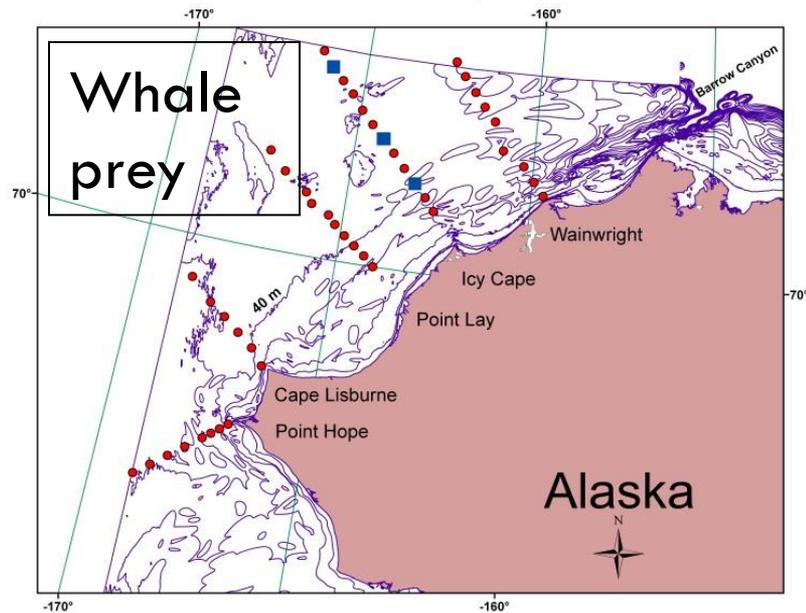
- ✧ Use passive acoustic techniques to document the general presence and detailed movements of bowhead, fin, gray, humpback, and other baleen whales in areas of potential seismic, drilling, construction, and production activities.
- ✧ Examine the changing Chukchi Sea ecosystem using biophysical moorings, shipboard observations and climate numerical models
- ✧ Link these data to the distribution and behavior of cetaceans to provide an integrated look at how changing regional and local conditions are affecting protected species.



Stations occupied in FY10.  
■ = biophysical moorings; ● = hydrographic and plankton stations



# Marine Mammal Surveys, 2012-2015





# SOAR: Synthesis of Arctic Research



- Ecosystem research is often discipline-focused from physics to marine mammals
- The **SOAR** aims to connect results across a spectra of science projects & local observations
- Science Steering Committee guides the program
- Workshops & analysis leading to peer-reviewed science; *Progress in Oceanography, Special Issue* (2014)
- In partnership with **PacMARS** and other synthesis efforts





# Desired Outcome

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Request ESMWG to:

- Provide advice on specific steps that NOAA could take to strengthen its current Arctic science programs, and
- Recommend the extent to which NOAA should act to create a more integrated and cohesive Arctic Science Enterprise.